

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Before the Board of Patent Appeals and Interferences

Atty Dkt. 829-585

C# M#

TC/A.U.: 1722

Examiner: M. SONG

Date: August 31, 2006

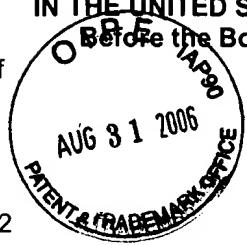
In re Patent Application of

TAKAHASHI et al.

Serial No. 09/936,818

Filed: February 28, 2002

Title: CRYSTAL GROWTH METHOD, PRODUCTION METHOD OF SEMICONDUCTOR
MICROSTRUCTURE, SEMICONDUCTOR DEVICE AND SYSTEM



Mail Stop Appeal Brief - Patents

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

Sir:

Correspondence Address Indication Form Attached.

NOTICE OF APPEAL

Applicant hereby **appeals** to the Board of Patent Appeals and Interferences
from the last decision of the Examiner twice/finally rejecting \$500.00 (1401)/\$250.00 (2401) \$
applicant's claim(s).

An appeal **BRIEF** is attached in the pending appeal of the
above-identified application

\$500.00 (1402)/\$250.00 (2402) \$ 500.00

Credit for fees paid in prior appeal without decision on merits

-\$ ()

A reply brief is attached.

(no fee)

Petition is hereby made to extend the current due date so as to cover the filing date of this
paper and attachment(s)

One Month Extension \$120.00 (1251)/\$60.00 (2251)

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Three Month Extensions \$1020.00 (1253)/\$510.00 (2253)

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"Small entity" statement attached.

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TOTAL FEE ENCLOSED \$ 500.00

Any future submission requiring an extension of time is hereby stated to include a petition for such time extension.

The Commissioner is hereby authorized to charge any deficiency, or credit any overpayment, in the fee(s) filed, or asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our **Account No. 14-1140**. A duplicate copy of this sheet is attached.

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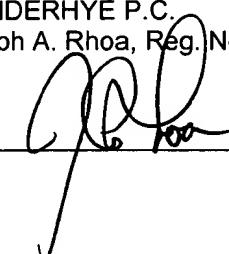
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* * * * *

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APPEAL BRIEF

Sir:

Applicant hereby appeals to the Board of Patent Appeals and Interferences from
the last decision of the Examiner.

09/05/2006 MAHMED1 00000031 09936818
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(I) REAL PARTY IN INTEREST

The real party in interest is Sharp Kabushiki Kaisha, a corporation of the country of Japan.

(II) RELATED APPEALS AND INTERFERENCES

The appellant, the undersigned, and the assignee are not aware of any related appeals, interferences, or judicial proceedings (past or present), which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

(III) STATUS OF CLAIMS

Claims 29, 32, 33 and 38-62 are pending and have been rejected. No claims have been substantively allowed. All of claims 29, 32, 33 and 38-62 are on appeal.

(IV) STATUS OF AMENDMENTS

No amendments have been filed since the date of the Final Rejection.

(V) SUMMARY OF CLAIMED SUBJECT MATTER

This section is for purposes of example and without limitation.

The invention of claim 29 relates to crystal growth method for a III-V compound semiconductor including, as V group components, nitrogen and at least one of arsenic (As), phosphorous (P), and antimony (Sb), where a technique selected from among a molecular beam epitaxial (MBE) and a gas source molecular beam epitaxial (GS-MBE) growth method is used (e.g., pg. 12, line 22 to pg. 13, line 22).

Claim 29 further calls for supplying aluminum and ammonium (NH₃) to a surface of the crystal so as to obtain a mixed crystal with a composition comprising nitrogen, wherein crystallization of the nitrogen from the ammonium which is supplied to the surface of the crystal into the surface of the crystal is accelerated by the aluminum supplied to the surface of the crystal (e.g., pg. 31, lines 1-25; pg. 11, line 6 to pg. 12, line 5; pg. 30, line 19 to pg. 32, line 3; pg. 33, line 10 to pg. 34, line 14).

Moreover, claim 29 states that the substrate is at a temperature of 450 degrees C or more and less than 640 degrees C when the aluminum and ammonium are supplied in growing the III-V compound semiconductor that includes, as V group components, nitrogen and at least one of arsenic (As), phosphorous (P), and antimony (Sb). The instant specification explains that temperatures lower than 450 degrees C and temperatures higher than 640 degrees C are undesirable (e.g., Fig. 4; pg. 37, lines 1-14; and pg. 13, lines 13-14). Temperature is an important aspect of methods according to certain embodiments of this invention, when used in combination with the simultaneous application of aluminum and ammonium. For example, it has been found that by using Al and nitrogen from ammonium together in a deposition process involving Molecular

Beam Epitaxy (MBE), it is possible to crystallize nitrogen into a mixed crystal in a more efficient manner at temperatures of 450 degrees C or more. However, using such a technique, it has surprisingly been found that substrate temperatures of higher than 640 or 680 degrees C are problematic because a nitride phase of AlGaN or the like, which is readily generated at high temperature(s), is mixed and causes phase separation (e.g., pg. 37, lines 1-14; and Fig. 4). Thus, it has surprisingly been found that the appropriate temperature range for the use of simultaneous Al and nitrogen in MBE is 450-640 degrees C.

Claim 32 requires that “a nitrogen composition is controlled based on an amount or composition ratio of added aluminum.” E.g., pg. 12, lines 10-15.

Claim 33 requires that the “aluminum is crystallized in a restricted region, whereby only in the restricted region, nitrogen is crystallized.” E.g., pg. 12, lines 16-21; pg. 50, line 10 to pg. 55, line 1. In other words, the nitrogen is crystallized in the restricted region, but not outside of the restricted region.

(VI) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Whether claims 29, 32, 33, 38-39, 42-50 and 53-62 are unpatentable under 35 U.S.C. Section 103(a) over Jiang (US 5,956,364) in view of Tomomura (WO 98/44539, US 6,358,822 used for translation purposes).
2. Whether claims 40, 41, 51 and 52 are unpatentable under 35 U.S.C. Section 103(a) over Jiang in view of Tomomura, and further in view of Ito.

(VII) ARGUMENT

It is axiomatic that in order for a reference to anticipate a claim, it must disclose, teach or suggest each and every feature recited in the claim. See, e.g., Kalman v. Kimberly-Clark Corp., 713 F.2d 760, 218 USPQ 781 (Fed. Cir. 1983). The USPTO has the burden in this respect.

Moreover, the USPTO has the burden under 35 U.S.C. Section 103 of establishing a *prima facie* case of obviousness. In re Piasecki, 745, F.2d 1468, 1471-72, 223 USPQ 785, 787-88 (Fed. Cir. 1984). It can satisfy this burden only by showing that some objective teaching in the prior art, or that knowledge generally available to one of ordinary skill in the art, would have led that individual to combine the relevant teachings of the references to arrive at the claimed invention. In re Fine, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). Before the USPTO may combine the disclosures of the references in order to establish a *prima facie* case of obviousness, there must be some suggestion for doing so. In re Jones, 958 F.2d 347 (Fed. Cir. 1992). Even assuming, *arguendo*, that a given combination of references is proper, the combination of references must in any event disclose the features of the claimed invention in order to render it obvious.

Claim 29

Claim 29 stands rejected under 35 U.S.C. Section 103(a) as being allegedly unpatentable over Jiang in view of Tomomura. This Section 103(a) rejection should be reversed for at least the following reasons.

Claim 29 requires “a technique selected from among a molecular beam epitaxial (MBE) growth method, and a gas source molecular beam epitaxial (GS-MBE) growth

method is used, supplying aluminum and ammonium (NH₃) to a surface of the crystal so as to obtain a mixed crystal with a composition comprising nitrogen, wherein crystallization of the nitrogen from the ammonium which is supplied to the surface of the crystal into the surface of the crystal is accelerated by the aluminum supplied to the surface of the crystal, and wherein the substrate is at a temperature of 450 degrees C or more and less than 640 degrees C when the aluminum and ammonium are supplied in growing the III-V compound semiconductor that includes, as V group components, nitrogen and at least one of arsenic (As), phosphorous (P), and antimony (Sb).” The instant specification explains that temperatures lower than 450 degrees C and temperatures higher than 640 degrees C are undesirable (e.g., Fig. 4; pg. 37, lines 1-14; and pg. 13, lines 13-14). Temperature is an important aspect of methods according to certain embodiments of this invention, when used in combination with the simultaneous application of aluminum and ammonium. For example, it has been found that by using Al and nitrogen from ammonium together in a deposition process involving Molecular Beam Epitaxy (MBE), it is possible to crystallize nitrogen into a mixed crystal in a more efficient manner at temperatures of 450 degrees C or more. However, using such a technique, it has surprisingly been found that substrate temperatures of higher than 640 or 680 degrees C are problematic because a nitride phase of AlGaN or the like, which is readily generated at high temperature(s), is mixed and causes phase separation (e.g., pg. 37, lines 1-14; and Fig. 4). Thus, it has surprisingly been found that the appropriate temperature range for the use of simultaneous Al and nitrogen in MBE is 450-640 degrees C. The criticality of this claimed temperature range has been established. The cited art fails to disclose or suggest these features of claim 29.

Jiang discloses a Vertical Cavity Surface Emitting Laser (VCSEL) with an integrated shaped cavity mirror, and the use of molecular beam epitaxy (MBE) to form indium gallium arsenide aluminum nitride (InGaAsAlN) (e.g., col. 3, lines 13-26). However, Jiang *fails* to disclose or suggest simultaneously supplying ammonium (NH₃) and aluminum (Al) to a surface of the crystal using a substrate temperature of from 450-640 degrees C, such that crystallization of the nitrogen from the ammonium is accelerated by the Al as required by claim 29. Jiang discloses nothing akin to these requirements of claim 29.

Recognizing this fundamental flaw in Jiang, the Office Action cites to Tomomura. Tomomura discloses forming GaInNAs using a substrate temperature of 580 degrees C (col. 5, lines 53-55; col. 7, lines 30-41). Tomomura teaches that a temperature of 500-750 degrees C should be used when NH₃ is used as the nitrogen source (col. 7, lines 30-41). Since Tomomura teaches that a temperature of 500-750 degrees C should be used when NH₃ is used as the nitrogen source, the Examiner contends that it would have been obvious to have used NH₃ as a nitrogen source in Jiang and to have used the temperature of 500-750 degrees C as taught by Tomomura. However, this Section 103(a) rejection is incorrect and fundamentally flawed for at least the following reasons.

While Tomomura teaches a substrate temperature of 500-750 degrees C when using NH₃ to form GaInNAs (col. 5, lines 47-57; col. 7, lines 30-41), Tomomura does not disclose or suggest using such temperatures when forming a layer with Al therein via MBE— which is a key point of the invention of claim 29. The instant inventors have surprisingly found that using temperatures from 450-640 degrees C during MBE is surprisingly beneficial *when supplying NH₃ and Al at the same time* in that crystallization

of the nitrogen from the ammonium is *accelerated* by the Al at this temperature range.

The cited art fails to disclose or suggest this unexpected phenomenon. Moreover, the unexpected results associated with this would rebut any alleged case or obviousness.

Tomomura's discussion at col. 15, lines 25-30, relied on by the Examiner, merely mentions As, P, Sb, Bi, B, Al, Ga and In in a laundry list of materials for a III-V compound. There is no discussion or suggestion by Tomomura in this respect of using temperatures from 450-640 degrees C during MBE when *supplying NH₃ and Al at the same time so that crystallization of the nitrogen from the ammonium is accelerated by the Al at this temperature range*. This portion of Tomomura does not even say that ammonium is used, and certainly does not state or suggest supplying ammonium and Al at the *same time*, let alone at the claimed temperature range in a MBE process as called for in claim 29. There is simply no suggestion in the cited art for the invention of claim 29; hindsight is not permitted. No *prima facie* case of obviousness has been made. To summarize, both Jiang and Tomomura fail to disclose or suggest *supplying NH₃ and Al at the same time so that crystallization of the nitrogen from the ammonium is accelerated by the Al in the claimed temperature range*.

Additionally, it is noted that Tomomura merely teaches that "the substrate temperature in a range of 500 to 750 degrees C can be used when NH₃ is used as the nitrogen source" (col. 7, lines 30-41). However, in contrast, claim 29 specifically requires that "wherein the substrate is at a temperature of 450 degrees C or more and less than 640 degrees C *when the aluminum and ammonium are applied* in growing the III-IV compound semiconductor . . ." Accordingly, Tomomura fails to disclose, teach or suggest setting such a substrate temperature in a range of 450-640 degrees C "when the

aluminum and ammonium are supplied” at the same time in growing the III-IV compound semiconductor as called for in claim 29. Again, hindsight is not permitted.

The Office Action contends that Tomomura suggests supplying aluminum and nitrogen simultaneously, citing col. 15, lines 25-31 (see pg. 7 of the Office Action). However, while Tomomura may have included Al in a laundry list of Group III elements, this does not mean that Al and ammonium are supplied simultaneously as required by claim 29. There is no disclosure or suggestion in Tomomura of simultaneously supplying ammonium (NH₃) and aluminum (Al) to a surface of the crystal using a substrate temperature of from 450-640 degrees. In this regard, the Office Action relies on impermissible hindsight. The Section 103(a) rejection of claim 29 should be reversed.

Claim 32

Claim 32 requires that “*a nitrogen composition is controlled based on an amount or composition ratio of added aluminum.*” E.g., pg. 12, lines 10-15. The cited art fails to disclose or suggest this feature. Without citing to any teaching in this regard, the Office Action merely contends that this feature would have been obvious. However, there is not suggestion or motivation in the cited art of controlling nitrogen composition “based on an amount or composition ratio of added aluminum” as required by claim 32. Both Jiang and Tomomura fail to disclose or suggest this feature. Hindsight is not permitted.

Claim 33

Claim 33 requires that the “*aluminum is crystallized in a restricted region, whereby only in the restricted region, nitrogen is crystallized.*” E.g., pg. 12, lines 16-21; pg. 50, line 10 to pg. 55, line 1. In other words, the nitrogen is crystallized in the restricted region, but not outside of the restricted region. The cited art fails to disclose or

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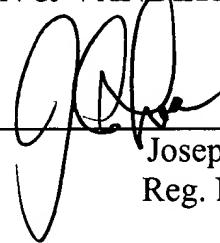
suggest this feature. Both Jiang and Tomomura fail to disclose or suggest that the nitrogen is crystallized in one region, but not in another region, as required by claim 33. The cited art is entirely unrelated to this feature of claim 33.

CONCLUSION

In conclusion it is believed that the application is in clear condition for allowance; therefore, early reversal of the Final Rejection and passage of the subject application to issue are earnestly solicited.

Respectfully submitted,

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(VIII) CLAIMS APPENDIX

29. A crystal growth method for a III-V compound semiconductor including, as V group components, nitrogen and at least one of arsenic (As), phosphorous (P), and antimony (Sb), the method comprising:

wherein a technique selected from among a molecular beam epitaxial (MBE) growth method, and a gas source molecular beam epitaxial (GS-MBE) growth method is used,

supplying aluminum and ammonium (NH₃) to a surface of the crystal so as to obtain a mixed crystal with a composition comprising nitrogen,

wherein crystallization of the nitrogen from the ammonium which is supplied to the surface of the crystal into the surface of the crystal is accelerated by the aluminum supplied to the surface of the crystal, and

wherein the substrate is at a temperature of 450 degrees C or more and less than 640 degrees C when the aluminum and ammonium are supplied in growing the III-V compound semiconductor that includes, as V group components, nitrogen and at least one of arsenic (As), phosphorous (P), and antimony (Sb).

32. A crystal growth method according to claim 29, wherein a nitrogen composition is controlled based on an amount or composition ratio of added aluminum.

33. A crystal growth method according to claim 29, wherein aluminum is crystallized in a restricted region, whereby only in the restricted region, nitrogen is crystallized.

38. A crystal growth method according to claim 29, wherein a surface of single crystal substrate is a crystal surface slanted from a (100) surface in a [011] direction (A direction) or a crystal face which is equivalent in a crystallographic sense to the slanted crystal surface.

39. A crystal growth method according to claim 38, wherein the slant angle is within a range equal to 2^0 or more and equal to 25^0 or less.

40. A crystal growth method according to claim 29, wherein one or more pairs of semiconductor layer A and semiconductor layer B are superposed, the semiconductor layer A including at least aluminum and nitrogen in its composition but not including indium in its composition, and the semiconductor layer B including at least indium in its composition but not including nitrogen in its composition.

41. A crystal growth method according to claim 40, wherein the thickness of each of the semiconductor layers A and B is from one to ten molecular layers.

42. A crystal growth method according to claim 29, wherein crystal growth is performed by applying a source material to a substrate in a crystal growth room which is evacuated of air, and a mean free path of a molecule of each source material is longer than a distance between the substrate and a source of the source material.

43. A crystal growth method according to claim 29, wherein ammonium in the form of gas is used as a nitrogen source material, and a source material of another element is obtained by evaporating a solid of a single element.

44. A crystal growth method according to claim 29, wherein ammonium in an undecomposed state is supplied as a nitrogen source material and decomposed on a surface of the substrate.

45. A crystal growth method according to claim 29, wherein crystal growth is performed over an underlying (sub-strate) crystal which does not include nitrogen as a principal element.

46. A crystal growth method according to claim 45, wherein the underlying (substrate) crystal is selected from GaAs, InP, GaP, GaSb, and Si.

47. A semiconductor device comprising a semiconductor layer formed by the crystal growth method of claim 29.

48. A semiconductor device according to claim 47, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

49. A semiconductor device comprising a semiconductor layer formed by the crystal growth method of claim 38.

50. A semiconductor device according to claim 49, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

51. A semiconductor device comprising a semiconductor layer formed by the crystal growth method of claim 40.

52. A semiconductor device according to claim 51, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

53. An apparatus which uses the semiconductor device of claim 47.

54. An apparatus which uses the semiconductor device of claim 49.

55. A semiconductor device comprising a semiconductor layer formed by the crystal growth method of claim 42.

56. A semiconductor device according to claim 55, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

57. A semiconductor device comprising a semiconductor layer formed by the crystal growth method of claim 43.

58. A semiconductor device according to claim 29, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

59. A semiconductor device comprising a semiconductor layer formed by the crystal growth method of claim 44.

60. A semiconductor device according to claim 59, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

61. A semiconductor device comprising a semiconductor layer formed by the crystal growth method of claim 45.

62. A semiconductor device according to claim 61, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

(IX) EVIDENCE APPENDIX

None

(X) RELATED PROCEEDINGS APPENDIX

None